Section 3.2 HIGH EMITTER CORRECTION FACTORS

3.2.1.1 Introduction

In the previous emissions inventory model, MVEI7G, a high emitter correction factor (HECF) was used to adjust the estimated model year specific emission rates such that they matched the model year specific emission rates observed in an independent data set. The HECF is not used in EMFAC2000 since the estimated model year specific emission rates closely match those observed in another independent data set. This section gives a brief background of the HECF, why it was used in MVEI7G, and why it became redundant in EMFAC2000.

3.2.1.2 Background

Prior to MVEI7G, it was often stated that the "the mobile source emissions inventory is underestimated by a factor of 2," and that "a minority of "high emitting" vehicles are responsible for majority of the emissions." The basic argument was that the CALIMFAC[1] model underrepresented the amount of high emitters that were present in the fleet at any given time. People speculated that CARB's low vehicle capture rate in surveillance programs resulted in a data set that contained fewer high emitting vehicles than those observed in remote sensing studies. It was theorized that a bias data set resulted from the reluctance of owners of tampered vehicles to participate in a state-operated vehicle-testing program. This data set, which was used in CALIMFAC for determining the average emission rate by regime and the population of vehicles in each regime, was responsible for an underestimation of the population of high emitting vehicles. In 1994, CARB conducted a Pilot IM program with the goal of assessing the relative merits of conducting vehicle inspections using either the IM240 or ASM tests. The program was designed such that participation was mandatory. This resulted in a 60% capture rate; the highest ever achieved by CARB for a testing program. During the development of the MVEI7G model, data from the IM Pilot program were compared the modeled rates for HC, CO and NOx from the CALIMFAC model. This analysis, detailed in a document entitled "Development of High Emitter Correction Factors[2]" indicated that the CALIMFAC model tended to under-predict the emissions of older model year vehicles, and slightly overestimate the emissions from newer vehicles. To rectify this, the MVEI7G model included a multiplicative high emitter correction factor, which was applied to both starting and running emission rates. The effect of this factor was to increase HC, CO and NOx emissions by 37%, 52% and 21%, respectively, for passenger cars in calendar year 1995.

In EMFAC2000, the HECF was made redundant because of fundamental improvements in the amount of data used in developing basic emission rates, and how this data was used in characterizing the vehicle fleet. The EMFAC2000 emission rates are based on testing more than 5,200 vehicles, which is more than double the number used in developing the MVEI7G emission rates. Sections 4.0 through 4.6 detail the steps taken in developing the basic emission rates for passenger cars, light-, and medium-duty trucks. These steps include adding data from: recent

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[1] The CALIMFAC model estimates basic emission rates for with and without IM. These rates were then input into the EMFAC model for adjustment with other correction factors.
[2] This is part of a compendium of documents for the MVEI7G document entitled "Derivation of Emission and Correction Factors for EMFAC7G."

surveillance programs where increased monetary incentives have resulted in a higher vehicle capture rate, special high mileage surveillance programs, USEPA's testing from Hammond, Indiana, and from IM evaluation programs (including the IM Pilot program). In addition to adding more data, checks were made to ensure that the vehicle malperformance rate observed in random roadside inspections matched those from surveillance programs. Further, the regime populations predicted by the model were also compared to those observed in surveillance programs, and steps were taken to address any deficiencies. The goal of these steps was to ensure that a representative data set was used in developing the basic emission rates. To validate this data set and verify staff's assumption that an external HECF was no longer necessary, the model year specific emission rates, as modeled by EMFAC2000, were compared to those observed from testing a random sample of vehicles. This is a useful technique for determining whether the emission reduction trends are modeled correctly and in identifying anomalous model year(s) where the modeled emission rates differ significantly from the observed rates. These comparisons only provide a validation of the model year specific gram per mile emission estimates and not the entire inventory, which includes vehicle activity and provides tons per day emission estimates. In addition, this methodology can only be used to compare emission rates, in this case exhaust emission rates, from light-duty vehicles since these vehicles were tested in the independent data set.

3.2.2 Methodology

The CARB routinely conducts surveillance test projects in an ongoing effort to improve the motor vehicle emissions inventory. During these projects, vehicles are randomly selected from the Department of Motor Vehicles' (DMV) vehicle registration database. Those vehicles registered within a 25-mile radius of CARB's Haagen-Smit laboratory (HSL) are procured and tested in an "as-received" condition. Vehicles are given a battery of tests, which include the FTP and UC dynamometer tests. The EMFAC2000 light-duty vehicle emission rates are based on data collected from vehicle surveillance projects. These include:

1. Data collected from light-duty vehicle surveillance projects 1 through 12.
2. Data from Inspection and Maintenance (I&M) evaluation projects.
3. Special high mileage test programs.
4. USEPA data from Hammond, Indiana and Ann Arbor, Michigan.

The database contains model year specific emission rates for vehicles tested at various ages since in every project; a cross section of the vehicle fleet is tested. The EMFAC2000 light-duty vehicle emission rates are based on approximately 5,200 vehicles covering 1968 to 1993 model years.

The EMFAC2000 estimated model year specific UC based emission rates were compared to the measured UC rates in the light-duty vehicle surveillance 13 project. In surveillance 13, 263 passenger cars were tested over the UC test cycle. Since the EMFAC2000 UC rates are adjusted for ambient temperature, relative humidity, the effect of air conditioning usage and speed; the model was modified to generate emission rates comparable to testing conditions at the HSL. The following changes were made to the EMFAC2000 model:

1. The modeled rates were indicative of vehicles in the South Coast Air Basin (SCAB) since light-duty vehicle surveillance 13 vehicles were procured from this area. In addition, it was assumed that these vehicles have undergone the same inspection and maintenance programs as modeled for the SCAB region.
2. The speed correction factors were disabled such that the modeled rates were comparable to the bag 2 rates of the UC test.
3. The temperature and relative humidity corrections were disabled. In the model, these correction factors account for the fact that vehicles are driven under ambient conditions that differ significantly from the standardized ambient conditions used in vehicle testing.
4. The correction factors for air conditioning usage were disabled.
5. Only passenger car emission rates were compared since this was the predominant vehicle class tested in surveillance 13.

3.2.3 Results

Figure 3.2-1 shows the comparison of the modeled HC rates from EMFAC2000 versus the average measured HC rates from passenger cars tested in surveillance 13. The average HC rate is highly influenced by the emission rates of outliers. Outliers are those vehicles with either significantly higher or lower emissions than the remaining vehicles in the model year group. Depending on the number of vehicles in the model year group, outliers can strongly influence the average emission rate. Therefore, Figure 3.2-1 also shows the minimum and maximum model year specific HC rates observed in surveillance 13 program. Figure 3.2-1 also shows the number of vehicles tested in each model year. Similarly, Figures 3.2-2 and 3.2-3 show the comparison of the modeled EMFAC2000 CO and NOx rates versus the observed CO and NOx rates from surveillance 13 project, respectively.

Figure 3.2-1 Comparison of the Modeled EMFAC2000 HC Rates Versus the Observed HC Rates from Surveillance 13 Project

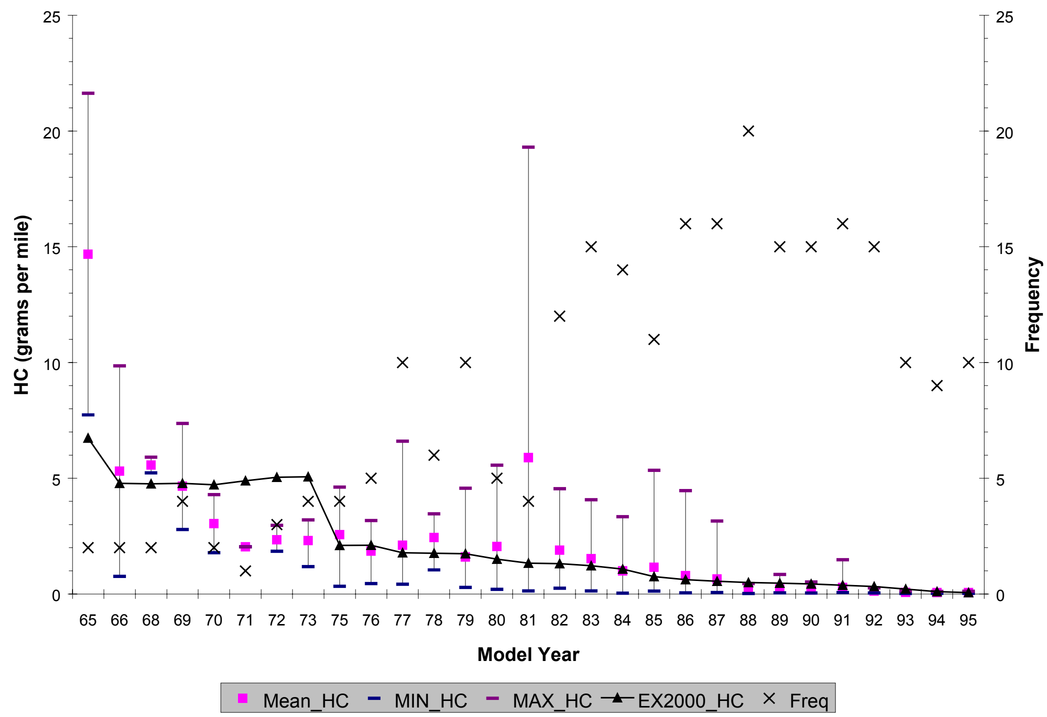


Figure 3.2-2 Comparison of the Modeled EMFAC2000 CO Rates Versus the Observed CO Rates from Surveillance 13 Project

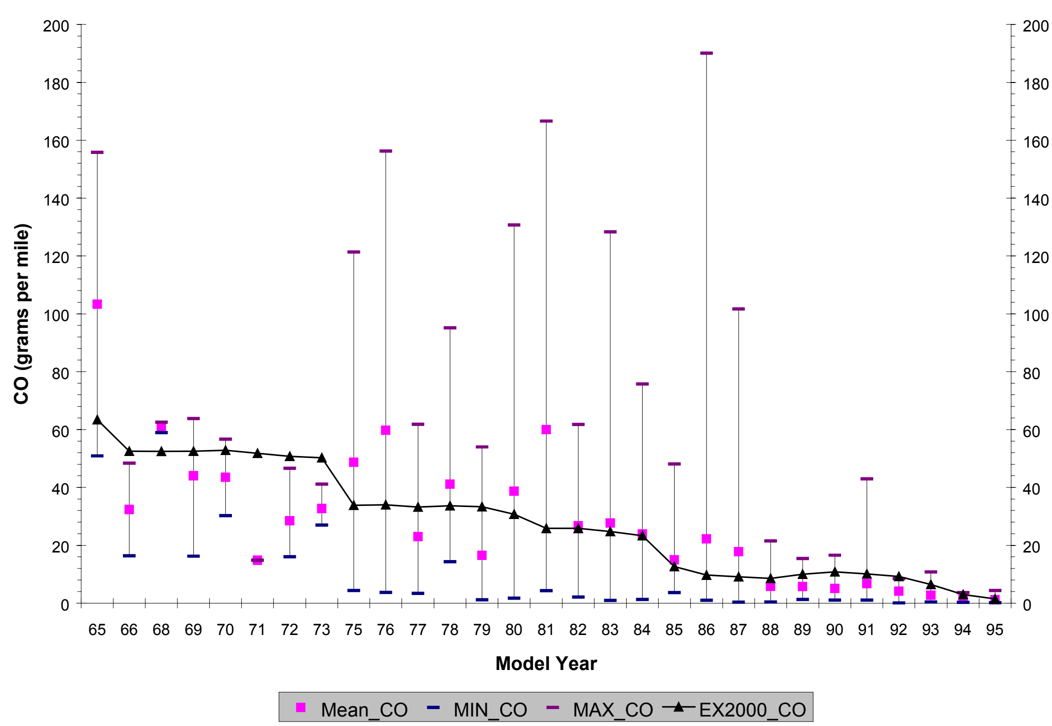
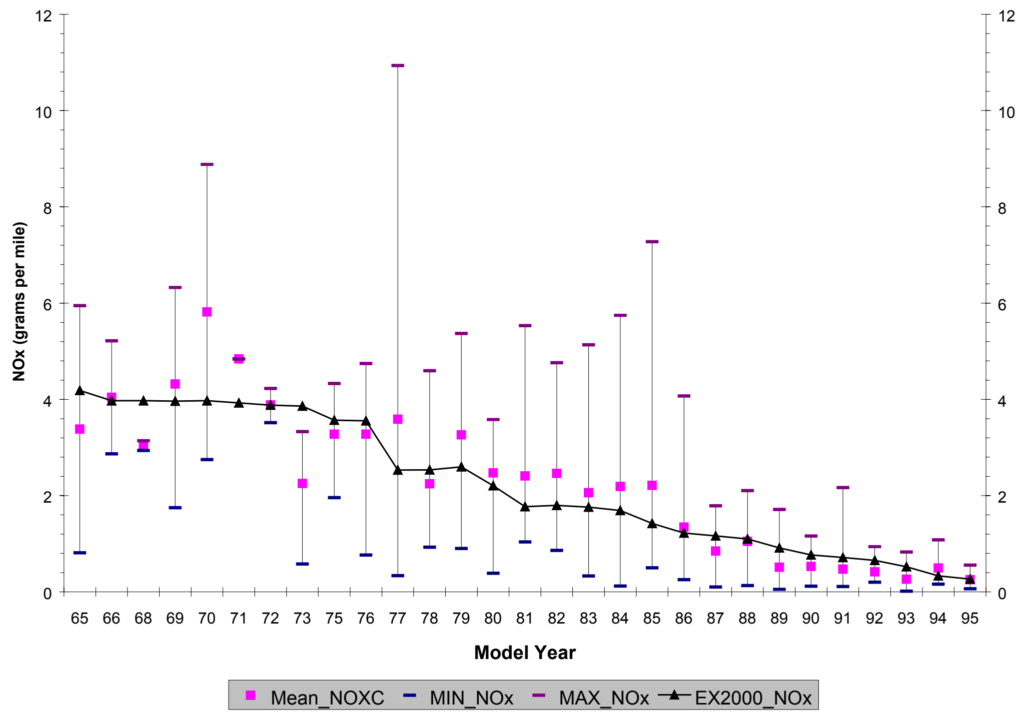


Figure 3.2-3 Comparison of the Modeled EMFAC2000 NOx Rates Versus the Observed NOx Rates from Surveillance 13 Project



Figures 3.2-1 to 3.2-3 graphically show how the estimated model year specific emission rates compare to the measured rates for passenger cars tested in the surveillance 13 project. While these figures show that the modeled rates are comparable to the measured rates they do not indicate what the impact is on the average fleet emission rate as a result of slight variations in the model year specific emission rates. To determine the impact on the average emission rate the modeled and observed model year specific emission rates were weighted by the vehicle miles traveled (VMT) in each model year. Table 3.2-1 shows the VMT weighted emission rate from EMFAC2000 and the surveillance 13 project. This table also shows the ratios of EMFAC2000/surveillance_13 emission estimates by pollutant.

Table 3.2-1 Average Fleet Emission Rates from EMFAC2000 and Surveillance 13

VMT Weighted Grams Per Mile Emission Estimates			
	HC	CO	NOx
EX2000	0.81	13.95	1.19
Surveillance_13	0.95	14.54	1.20
Ratio (*)	0.85	0.96	0.99
Ratio (*) = (Modeled EMFAC2000) / (Observed in Surv 13)			

3.2.4 Discussion

At first glance, Figures 3.2-1 and 3.2-2 suggests that the modeled HC and CO rates for model years 1969 to 1973 are much higher than the observed HC and CO rates, respectively. This may be true, however, the observed rates are based on the average of two to four vehicles in each model year as indicated by the frequency of vehicles tested. The limited sample size prevents any meaningful comparisons of the average emission rate for vehicles in these model years. It could be that the observed rates are lower than the modeled rates by the mere fact that people who own older cars have maintained them and hence there a decline the deterioration rates beyond a certain age. To answer this question, one should test a representative sample of vehicles in each model year and then compare the measured rates to the modeled rates. However, in a surveillance project, vehicles are tested to represent a snap shot of the vehicle fleet in that calendar year, hence, it is dominated by newer vehicles. The data from newer vehicles are used in updating emission rates of newer technology vehicles, which will dominate future calendar year forecasts. This issue will be revisited if similar trends are observed in future surveillance projects.

Figure 3.2-2 indicates that the modeled CO rates for model years 1988-1995 are higher than the observed CO rates. For these vehicles sample size is not an issue since the observed rates are based on testing a minimum of nine vehicles in each model year group. Unlike the differences in older model year emission rates, slight differences in the emission rates of newer model years can result in larger differences on the average fleet emission rate because the majority of the VMT comes from newer vehicles. One should evaluate additional data sets to verify this difference in CO emission rates for newer vehicles. This analysis will also point to the causes for the over-prediction in the emission rates for CO. The reasons may be:

1. Regime growth rates. The modeled CO emissions may be deteriorating at a faster rate than what is observed.
2. Regime specific emission rates. The regime specific emission rates may be slightly higher than what is observed.
3. The inspection and maintenance program may be more effective at lowering CO emissions than currently modeled.
4. Any combination of above reasons may cause the modeled CO emission rates to be higher than the measured CO rates.

Despite these differences, Table 3.2-1 indicates that the modeled HC, CO and NOx emissions are comparable to the observed emission estimates. The ratio of the modeled versus observed rates is below 1 for all three pollutants suggesting an underestimation of 1 to 15 percent.

3.2.5 Recommendations

1. Staff believes that the HECF should not be used in EMFAC2000 since there is little difference between the modeled and observed rates. However, similar analyses should be performed using additional data sources. These analyses can be used to either confirm or repudiate some of the observations noted from comparing the modeled EMFAC2000

emission rates to the measured emission rates. These analyses will highlight those model years where more data is needed or where the modeled rates need to be changed.

2. These comparisons should be done for all other vehicle classes and fuel types. While this is data and resource intensive, one will be able to gauge how close the modeled rates are to the measured rates. These comparisons will also identify data sources, which can be used in future, model updates.
3. The modeled rates should be compared to Bureau of Automotive Repair's (BAR) smog check test data from their two-percent audit sample. The BAR sends two percent of randomly selected vehicles to test-only centers. These vehicles should also be tested over a transient cycle, which measures emissions in grams per mile. These measurements, after conversion to an UC basis, can be compared to the modeled UC rates by vehicle class. This methodology has its own limitations; however, it may be a good technique for identifying anomalies in the model year specific emission rates.